



R.C.A. INSTITUTES.

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Technical Lesson 19

GRAPHS

The graph, more commonly known as a "curve", is a simple and convenient way of showing the relation between any two quantities or values. The curve diagram is employed for purposes other than Radio. It may be used to show the distance one walks during a given time, or it may be employed to show conditions of business over a period of time.

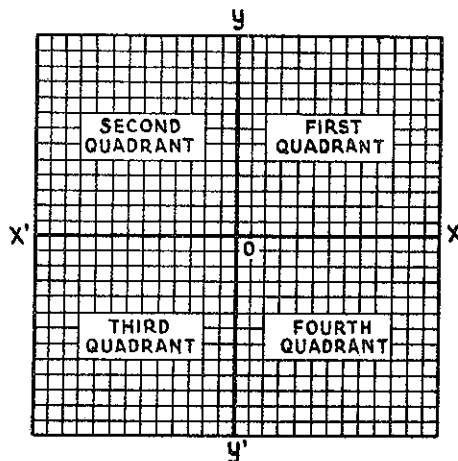


Figure 1

The curve is really a point picture because it represents to us, by a number of points connected by a line, certain quantities, values or conditions at a glance. The graph or curve diagram is generally drawn on a sheet of paper called graph-paper, ruled off into squares by horizontal and vertical lines as shown in Figure 1. The foundation of all graphs is pictured in Figure 2.

We will draw two lines as shown in Figure 2, - the first $X'OX$ and the second $Y'OY$. These lines separate a plane into four parts, and these four parts are called quadrants and numbered quadrant 1, 2, 3 and 4. The center marked 0 (zero) is considered to be the zero value of any quantity. When it is desired to

show decreases in a value they are shown either below the line $X'OX$, or to the left of the line $Y'OY$. This is illustrated in Figure 3 where decreasing values are indicated by the negative sign (-) while increasing values are indicated by the positive sign (+). The horizontal line $X'OX$ is called the "X" axis, or abscissae, and the vertical line $Y'OY$ is called the "Y" axis, or ordinate.

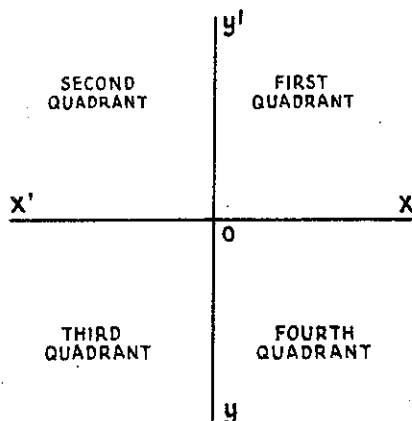


Figure 2

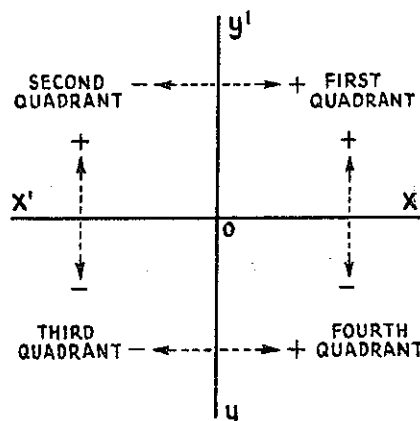


Figure 3

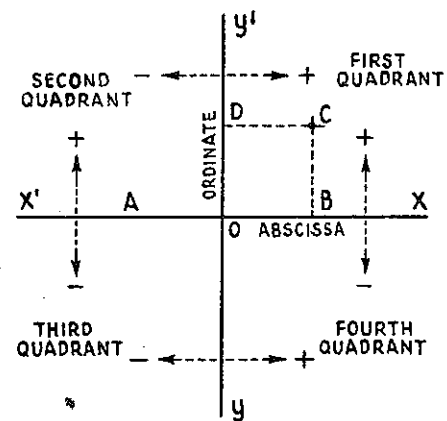


Figure 4

When positive values only are to be shown the first quadrant is used. How this operates is shown in Figure 4. Starting at zero make an X movement which, we will say, carries you to point B. At this point erect a perpendicular to the line OX, also called the abscissae, to an indefinite length. Begin again at zero and make a "Y" movement along the ordinate OY' to point "D". Draw a line at D perpendicular to line OY', or the ordinate, to an indefinite length also. At the

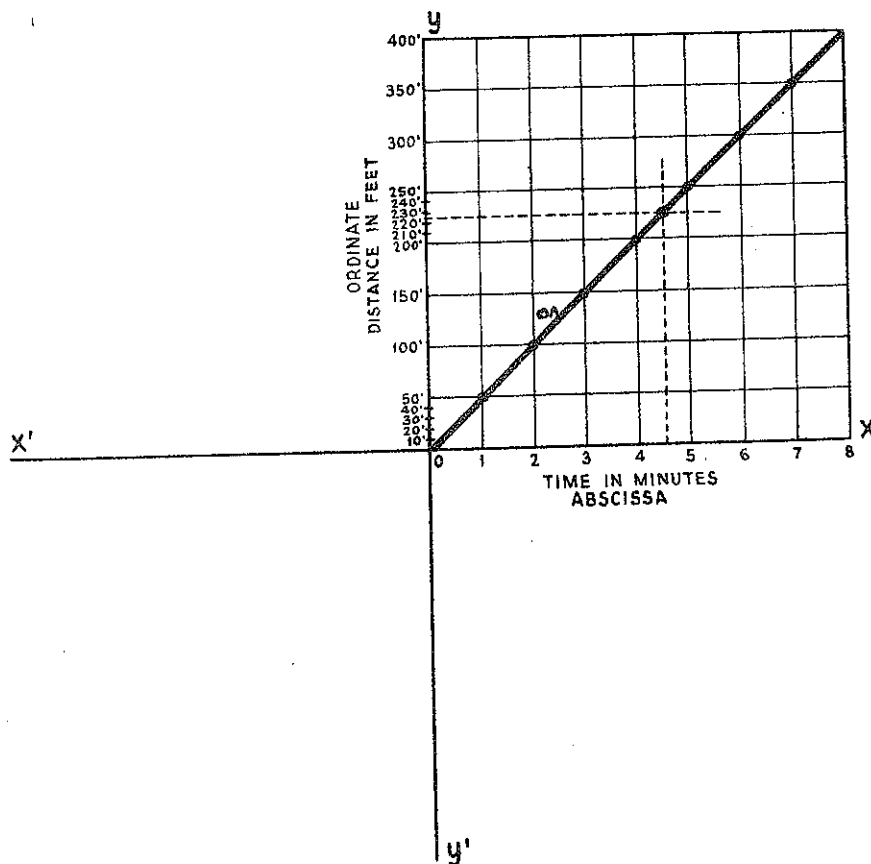


Figure 5

intersections of these lines, or at point C, place a dot. This is called plotting the point. Both movements shown have been increasing, or positive, movements and when positive values only are involved the first quadrant is used.

Suppose you walk from a given point for 8 minutes at the rate of 50 feet per minute what distance would you have covered in the 8 minutes? At the same rate what distance would you cover in 4 1/2 minutes? The answer to these questions can be shown by graph Figure 5. First lay off the abscissae, allowing 1/4 inch to represent one minute, then lay off the ordinates, allowing 1/4 inch to represent 50 feet.

Now if the rate you travel is 50 feet a minute look along the abscissae until you find one minute. Move up the vertical line until you meet the

horizontal which is drawn opposite the numeral 50 and, where this vertical and horizontal line intersects, place a dot. Do the same for each minute of travel, - this is called, "plotting the point". Then beginning at zero (0) draw a line through the points just located. This line will show that you have walked in a straight line and covered a distance of 400 feet in 8 minutes. To find the distance traveled in $4\frac{1}{2}$ minutes look along the abscissae until you find number 4, or four minutes. Half way between 4 and 5 will be $4\frac{1}{2}$ minutes. Erect a vertical line shown by the dotted line until it intersects line OA. From this point draw a line parallel with the abscissae until it meets the ordinate OY. Where this line meets the ordinate will show the distance walked in $4\frac{1}{2}$ minutes. Notice that this line passes midway between 220 and 230 feet, which is 225 feet. 225 feet is the distance travelled in $4\frac{1}{2}$ minutes.

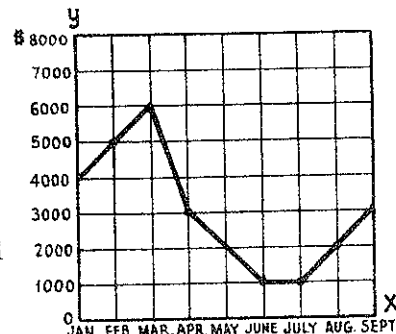


Figure 6

Suppose you were a merchant and you wished to plot fluctuation of your sales over a period of 9 months, beginning with January. The first thing to do is to rule off a piece of paper horizontally and vertically and, at the bottom of each vertical line, write the name of the months and, at the left of each horizontal line, assign a number representing dollars. If you prefer you may let the horizontal lines represent months and the vertical lines dollars. In Figure 6 we have drawn it up according to the first method.

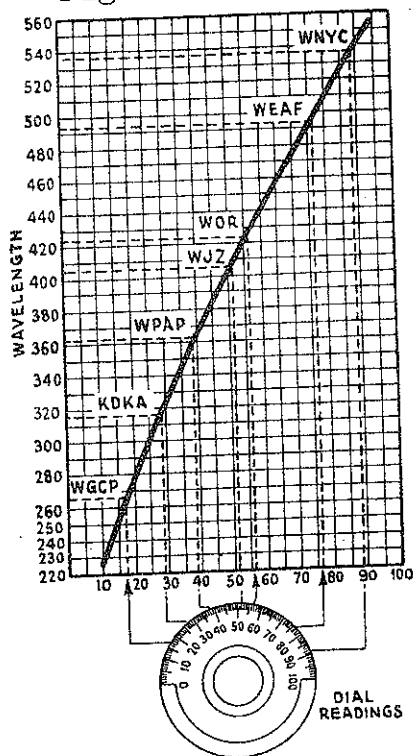


Figure 7

If, in January you did a \$4000 business place a dot opposite \$4000 and on the January ordinate. February you did a \$5000 business, so on the vertical line, or ordinate representing February, you place another dot, and so on for each month. Now by connecting these dots with a line you have a curve indicating the trend of business over a period of months. You observe that your business increased during January, February and March and between March and April it decreased to \$3000, and continued to decrease until June, where it remained the same for one month. In August it began to increase and in September it increased over August.

The owner of a receiving set can plot a curve which will assist him in locating stations when the wave length is known. Rule off a sheet of paper as shown in Figure 7. Along the abscissae allow each square to represent five divisions on the dial of the receiver. Along the ordinate mark the wave lengths. In starting the curve plot a few points representing the stations which you receive easily and the wave lengths of which you know. You should at least plot three or four, for example, WEA, WOR, WJZ, WPAP, which stations are located fairly in the center of

the broadcast wave length band. When you have completed this draw a line through the pointer just located. When such a curve is carefully drawn it is useful in locating other stations of unknown wave length. By careful study of Figure 7 you should be able to plot a curve of your own receiver. It may be necessary, however, in the case of a three dial receiver to make three separate curves.

THE SINE CURVE

The variations in any oscillatory motion or value may be shown by the use of the sine curve regardless of whether it is the variation in the value of an alternating current or the variation in the speed of a swinging pendulum.

A sine curve may be constructed as follows: Let the point A, Figure 8, move at a uniform rate of speed around a circular path in the direction indicated by the arrow. The angle ϕ will uniformly increase from 0 (zero) to 180 degrees and then from 180 degrees to 360 degrees. The length of the perpendicular, or line AB, which is dropped from point A to the horizontal axis of the circle, is proportional to the angle ϕ because the sine ϕ is equal to the quotient of AB divided by the hypotenuse OA, which in this case is the radius of the circle and does not change in value but remains constant throughout the revolution.

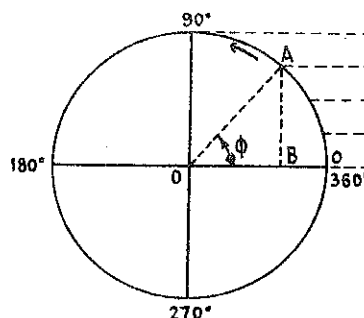


Figure 8

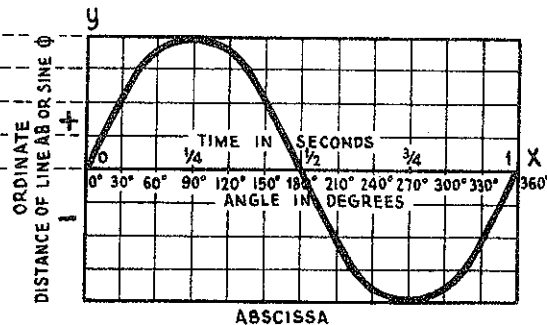


Figure 9

It will be seen that the length of the line AB varies from 0 (zero) to the maximum length, and it is equal to OA at 90 degrees as A revolves. As A continues to revolve the line AB gradually decreases in length until, at 180 degrees, it is again (0) zero length. On leaving 180 degrees it again increases in length until 270 degrees is reached, when it is maximum, and then it decreases in length to 0 (zero) when reaching zero degrees.

In order to distinguish between the varying lengths of AB above and below the horizontal axis of the circle the values of AB above the horizontal axis are called positive (+) values and below the horizontal axis negative (-) values. During the revolution of point A it will be noted that the line AB does not vary in length at a uniform rate even though the speed is uniform. Its length varies rapidly at first, then more and more slowly and, when nearing 90 degrees its length remains nearly constant. Upon passing 90 degrees the length of line AB decreases,

slowly at first until, nearing 180 degrees, it decreases very rapidly until its length is 0 (zero). To plot a curve representing the length of the line AB, as it varies with the revolving point A, we rule off a sheet of paper somewhat as shown in Figure 9, plotting the values of its varying length along the ordinate, or vertical Y axis, and the time along the horizontal or X axis. Since the length of the line AB is proportional to the sine of the angle ϕ , the vertical or Y axis may be used to represent the sine of the angle ϕ , and the changes in angle ϕ , being proportional to the length of time required to move A from one point to another as it revolves, the distances along the horizontal axis may also represent the values of the angle ϕ .

In plotting the varying length of line AB through 360 degrees the curve shown in the figure is the result.

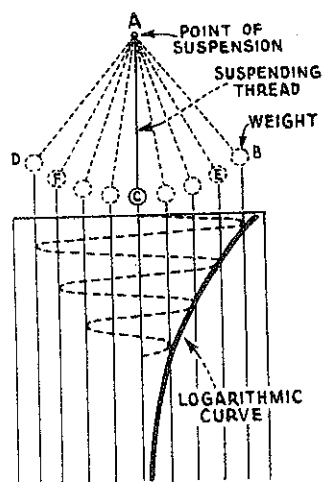


Figure 10

THE LOGARITHMIC CURVE

The logarithmic curve is one which may have no definite minimum point in a curve showing the decrease of a value or quantity and no definite maximum point when showing an increase in a value or quantity. The logarithmic curve may therefore be used to show the rate of increase or decrease of a value or quantity. When you take up the study of transmitters you will learn of damped electrical oscillations which decrease in value relative to amplitude according to a logarithmic law and from which a logarithmic curve may be taken.

To enable us to describe a logarithmic curve we will use the same analogy employed to explain the logarithmic decrement of electrical oscillations which are created in an antenna or other circuit by means of condenser discharges. A weight suspended by a fine thread, when at rest, will assume the position AC as shown in Figure 10. If you draw the weight aside from its vertical position AC to any other position, for example position AB, and then release the weight it will descend from B toward C, in the arc of a circle. The momentum it has acquired

will cause it to pass point C, rising against gravity, and it will rise nearly to point D which is in the same horizontal line as B. It then reverses the motion and, on passing C, will rise to a point short of B, for example E, and again reversing the motion it will swing back to point F. Thus the weight will swing backward and forward on both sides of line AC until it is brought to rest by the resistance of the air and the friction at point A.

The swing of the weight from B to D or from D to B is called one oscillation.

The arc, measured in degrees, from C to D, is called the amplitude of the oscillation. If we observe the length or amplitude of the successive swings of the weight we would obtain a group of decaying oscillations, the amplitude of each successive oscillation bearing a definite ratio to one another.

The rate at which these oscillations die out depends upon the resistance offered to the weight. This resistance is called the Damping Factor.

If we attach a piece of cardboard to the string, the oscillations of the weight would come to a stop in a much shorter period and they would be called highly damped oscillations.

If we draw a continuous line which is tangent to and connects the maximum point of each oscillation as we have done in Figure 10 we will have constructed a Logarithmic curve. In this case the curve is showing a decreasing value. It may be used however to show the increase in a value or quantity as well.

EXAMINATION - LESSON 19

1. What is meant by "X" axis?
2. What is meant by "Y" axis?
3. What is the "abscissae"?
4. What is the "ordinate"?
5. If a movement is caused along the "X" axis is it a positive or a negative movement?
6. Is the movement to the left of the "Y" axis positive or negative?
7. What is meant by the term, "plotting the point"?
8. Of what use is a curve diagram?
9. If a movement along the "X" axis is taken in the negative direction and then a movement in the negative direction is taken along the "Y" axis, which quadrant will this take the movement into?
10. What does a sine curve show?